Dimmer with 0-10 V Control Input

for our Light Mixer Panel

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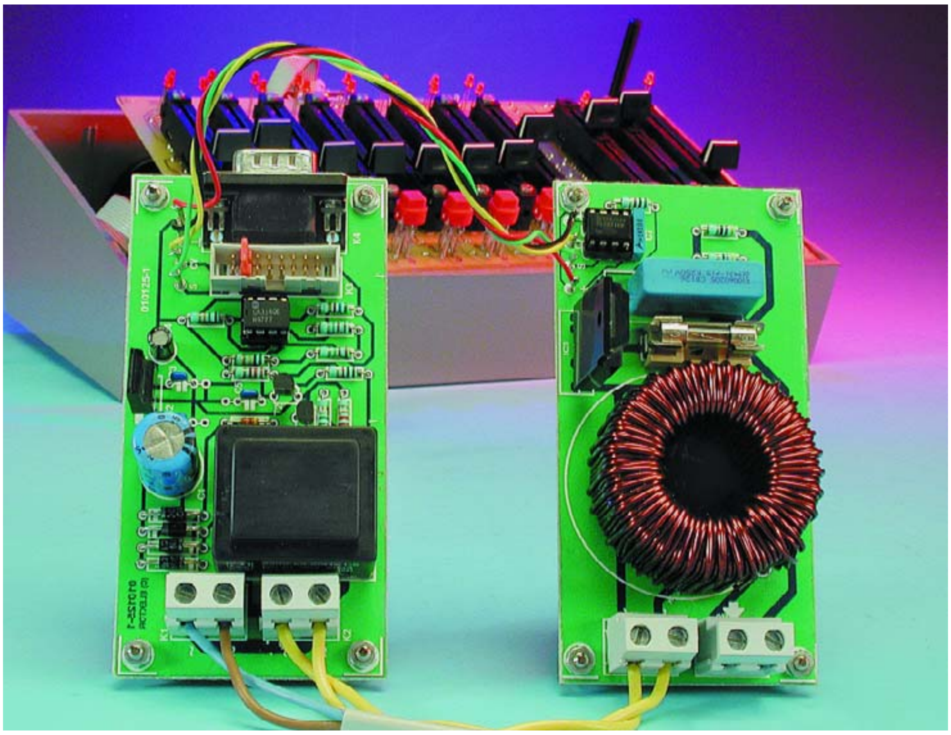
At the end of the Light Mixer Panel article published in last year's February issue we promised to complete the project with a compatible dimmer. Sure, the DMX Dimmer published in May 2002 could be used for the purpose, but the design is rather too extensive and complex to act as a simple dimmer. The circuit presented in this article is much simpler and cheaper!



The 8-channel Light Mixer Panel published in February 2002 was well received by many readers interested in sound & light equipment, mainly because it was affordable and fairly easy to integrate in existing lighting systems. However, besides praise for the design we also received many requests for an associated dimmer circuit capable of accepting the standardised 0-10 V control signals supplied by the Mixer panel outputs. Although suitable dimmers with a 0-10 V control input are available commercially, the true DIY enthusiast will, of course, insist on building one himself, in line with his efforts a building the Light Mixer Panel.

Although the DMX Dimmer published in May 2002 partly fulfilled the wishes of lights technicians, its design was obviously geared to semi-professional realms and control from a digital DMX system. Few of you who require a couple of simple dimmers will be prepared to invest in a hefty processor controlled circuit, even if it is designed and built to perfection.

To cut a long story short, there was a continuing need for a simple, straightforward dimmer suitable for lamp powers up to about 1,000 watts and with an input that's compatible with the industry standard 0-10 V control voltage. Well , that's exactly what we present in this article.

Two separate circuits

The basic design of the dimmer circuit follows the simplest and most rudimentary approach we could think of. The actual dimming is done using an opto-triac and phase angle control. The triac is driven by a comparator that compares the 0-10 V control voltage supplied by the Light Mixer Panel (or another compatible source) with a triangular voltage of about 10 V. In fact, we are looking at a pulsewidth control system here — the higher the control voltage, the longer the 'High' time of the pulse at the comparator output. Consequently, the triac will conduct longer and the lamp will light brighter. So, the only thing we need besides the comparator and the opto-triac is a sawtooth voltage. Generating such a waveform is not problematic as we'll see a bit further on. Because the sawtooth voltage may be used for several parallel-connected comparators, the circuit has been designed so that it can be split in two parts: controller and dimmer. The first circuit contains the sawtooth generator, a simple stabilised power supply for the opamps and a connector for the control voltages received from the Light Mixer Panel. The dimmer circuitry comprises little more than the comparator, the opto-triac and a suppressor coil.

Each functional section is mounted on a separate board, allowing several dimmer circuits to be connected to a common control circuit. This is particularly useful if several spotlights are clustered in a rack or on a tripod. Each spotlight then has its own dimmer module (and may be controlled separately), and each cluster has its own control board.

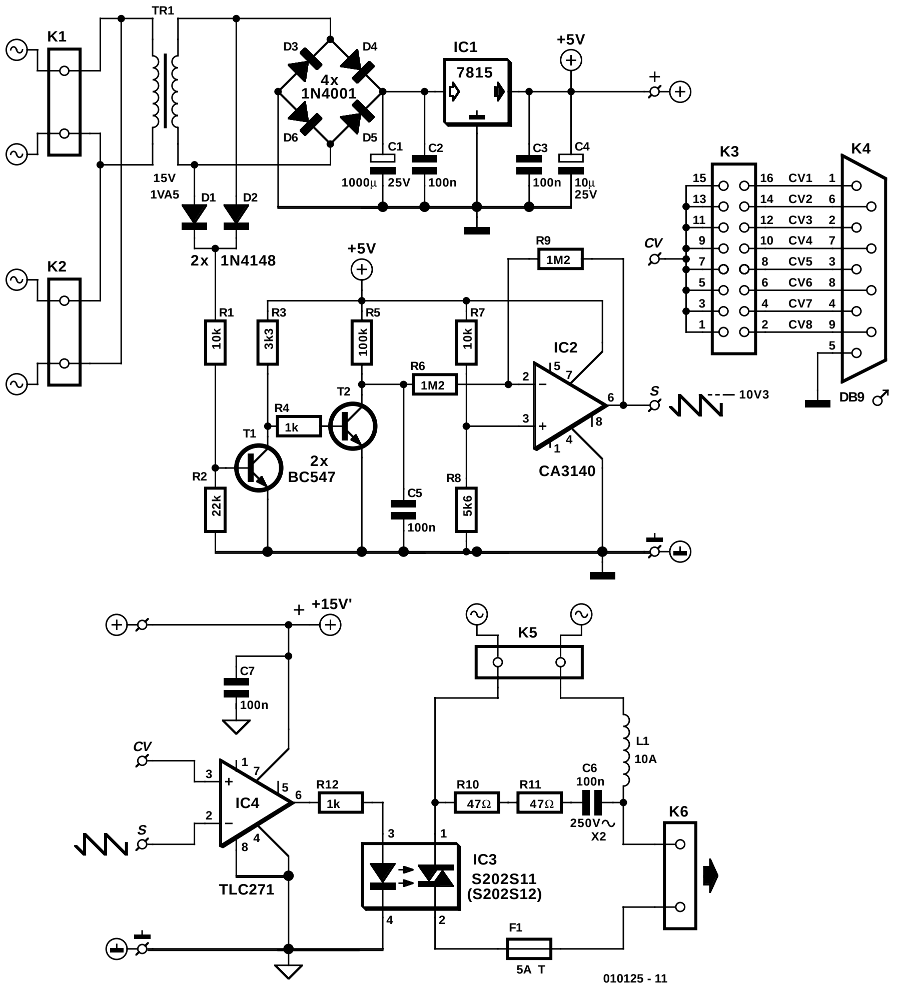


Figure 1. The circuit diagram may be divided into a control and a dimmer section. The control voltages supplied by the Light Mixer panel arrive on connector K4.

Control Module

The complete circuit of the dimmer is given in **Figure 1**. The upper part of the drawing describes the control module.

Let's first have a look at the connectors. The mains voltage is connected to one of the parallel-connected terminal blocks K1 or K2. The other terminal block may be used to feed the mains voltage through to K5 on the dimmer module(s). Note, however, that the maximum current of 15 A for these terminal blocks is not exceeded. In case of doubt it is better to provide each dimmer module with its own mains inlet.

The 9-way sub-D connector labelled K4 is intended for connecting the eight control voltages arriving from K2 on the Mixer Panel. The connection is made using a piece of 9-way flatcable terminated with a female connector (socket) at one end and a male connector (plug) at the other. The socket side goes to K4. Double-row pinheader K3 has been added to set the desired channel number with the aid of a jumper. Starting from 'CV' (control voltage) the control voltage is looped through to the identically labelled terminals on the dimmer module(s). Incidentally, on K3 at the side of K4 it is also possible to take control voltages from other channels.

The next sub-circuit to discuss is the sawtooth generator. The circuit around D1, D2 and T1 generates pulses around the zero-crossing of the mains voltage. Via T2, these pulses quickly discharge capacitor C5. During the Off time of T2, C5 is loaded again via R5. This process causes a sawtooth-shaped voltage on C5. This waveform is inverted by IC2 and amplified to a ramp voltage with a maximum swing of about 10 V. From point 'S', the auxiliary voltage is 'copied' to the corresponding terminal on the dimmer module(s).

The remaining sub-circuit in the control module is a simple stabilised 15-volt power supply unit for the opamps. The PSU consists of transformer Tr1, bridge rectifier D3-D6, reservoir capacitor C1 and voltage regulator IC1.

Dimmer module

First, the connectors again: the mains voltage is connected to K5 and the spotlight to be dimmed, to K6.

IC4 compares the sawtooth voltage (terminal S) with the control voltage from the Light Mixer Panel point (CV). The higher the control voltage, the longer the output of IC4 will remain High — the LED opto-triac IC3 is then driven longer, causing the lamp connected to K6 to light brighter.

Starting from the control board, the ±15-V supply voltage is connected through via the pins marked with the 'ground' and 'plus' labels.

When several dimmer modules are connected to a single control, module, the necessary control voltages may be taken directly from K3 (pin 2 = channel 1; pin 4 = channel 4; etc.)

Soldering

The artwork for the printed circuit boards of

COMPONENTS LIST

Resistors:
R1,R7 = 10kΩ
R2 = 22kΩ
R3 = 3kΩ3
R4,R12 = 1kΩ
R5 = 100kΩ
R6,R9 = 1MΩ2
R8 = 5kΩ6
R10,R11 = 47Ω

Capacitors:
C1 = 1000µF 25V radial
C2,C3,C5,C7 = 100nF
C4 = 10µF 25V radial
C6 = 100nF 250VAC Class X2

Inductors:
L1 = 10A triac suppressor coil, 50-100µH

Semiconductors:
D1,D2 = 1N4148
D3-D6 = 1N4001
T1,T2 = BC547
IC1 = 7815
IC2 = CA3140E
IC3 = S201S01 or S202S11
IC4 = TLC271CP

Miscellaneous:
K1,K2,K5,K6 = 2-way PCB terminal block, lead pitch 7.5mm
K3 = 16-way pinheader
K4 = 9-way sub-D connector, male, PCB mount, angled pins
TR1 = 15V 1VA5 e.g., Hahn type BV EI 303 2033
F1 = 1.25 A, slow, with PCB mount holder
PCBs, order code **010125-1** (control module), **010125-2** (dimmer module), see Readers Services page.

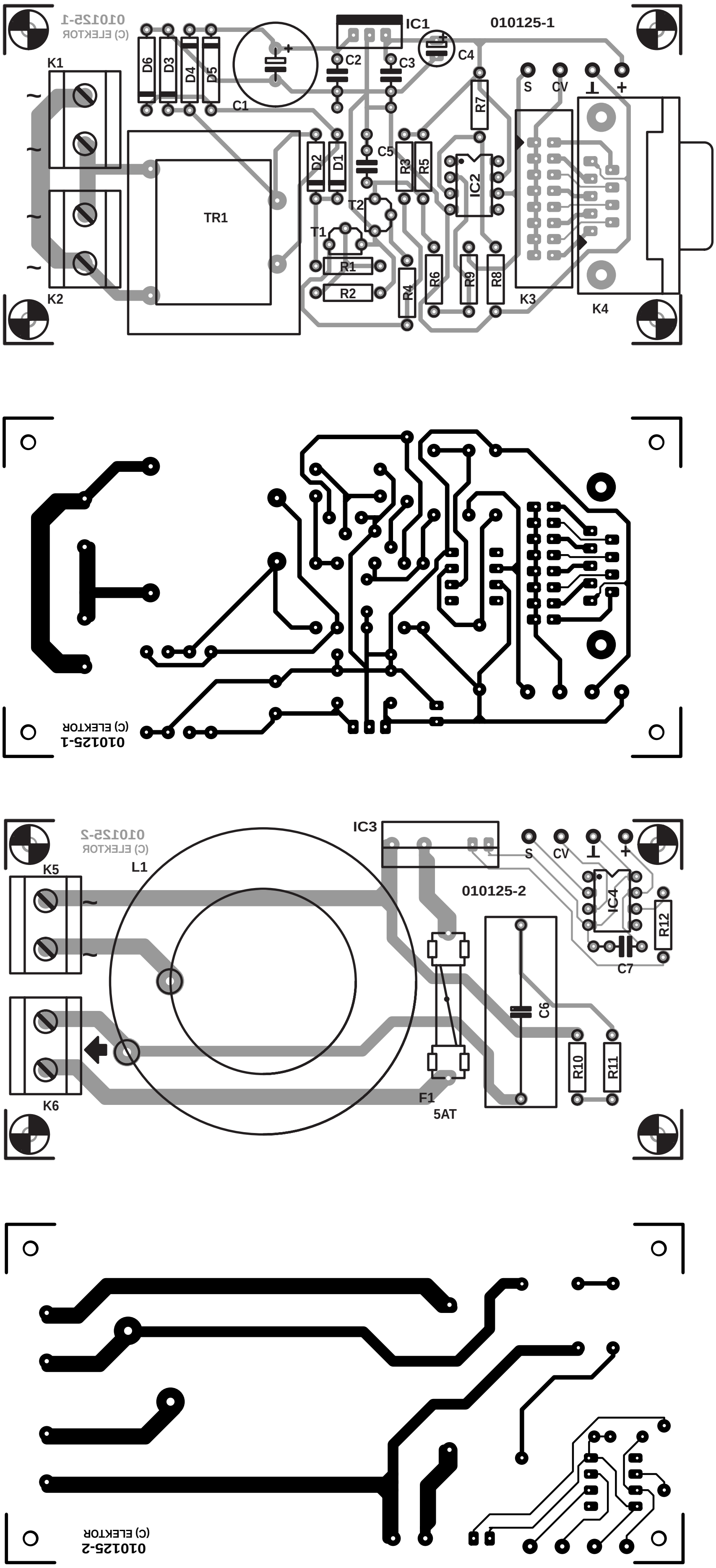


Figure 2. The control and dimmer circuits have their own printed circuit board.
That allows multiple dimmer modules to be hooked up to a common control board (boards available ready-made).

the two modules is shown in **Figure 2**. Although the dimmer board holds fewer components than the control board, the two are of equal dimensions mainly because of the bulky size of the 10-A suppressor coil (L1).

Stuffing these boards is not something to baulk at. The number of components is within reason and there are no pitfalls or problematic details. We would, however, advise to spend just a little more time and attention than usual to the solder work, so as to avoid any risk of short-circuits on the board caused by solder blobs, splashes and other unwanted links. After all, both boards are connected to the mains so you simply cannot afford to be less than careful here.

Now that we are on the subject, please read the *Electrical Safety* page which is occasionally printed in this magazine (if you do not have a copy, we will gladly send you one). **Never work on the circuit when it is connected to the mains. The mains voltage is potentially lethal.**

Enclosure

For safety's sake the circuit may only be built into an ABS (solid plastic) case. Make sure you install an approved mains appliance inlet as well as safe and sound connections for the spotlights. The connections between the various mains inlets and K1, K2, K5 and K6 should, of course, be made in properly insulated wire with a cross-sectional area of at least 1.5 mm^2. The links between points S, CV 'ground' and '+' may be made using light-duty insulated wire.

If a combination of one control board and one dimmer board is applied locally, then a channel is set on K3 using a jumper or wire link. Next, the points CV on the two boards may be linked. In a configuration with several dimmer boards and one control board, each CV terminal on the dimmer boards is separately connected to the desired channel pin on connector K3. That is easily done with the aid of, say, a header and a length of flatcable.

According to electrical safety regulations, the case should have a label attached on it stating salient information like operating voltage and fuse rating. A suggested format is included in the circuit diagram in Figure 1.

Up to 1,000 watts

Although the opto-triac used here is rated for a continuous current of 8 A we deemed it safer to remain well under this specification. Fuse F1 is therefore dimensioned for a maximum lamp power of 1,000 watts (assuming a mains voltage of 230 volts). In most cases, that will be sufficient while minimizing the risk of serious damage when something goes wrong at such a relatively low power level.

For lamp powers up to 500 watts no cooling device is required for IC3. Above 500 watts, we recommend fitting a small heatsink and drilling a few ventilation holes in the case so the heat does not build up.

Short current surges exceeding the maximum value of 8 A, for instance, when cold lamps come on, need not worry us because the opto-triacs type S202S11 and S202S12 mentioned in the parts list can withstand peak currents up to 80 A (!)

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